Present status and perspective of tiger research in China[1]

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Abstract This paper reviewed the present status of research about tiger in China. At present, four survival subspecies are endangered in China. Tiger has decreased greatly in number, and its distribution has limited to some areas. The published papers on morphology and anatomy were relatively few, while much work has been done on physiology and biochemistry of captive tigers. The author pointed out a few further research fields. The studies of chromosomes, gene, cloning and establishment of gene bank should be mostly focusing fields. Feeding and breeding techniques must be improved and reinforced.
Key words: Tiger, Biology, Present status

Introduction

Tiger is a large carnivore species. The earliest record of tiger in China can be traced back to 4 000 years ago. A few foreign researchers began to study tigers in China before 1950s (Ma 1983). Only after the establishment of the People Republic of China, were systematic studies of tiger carried out, mostly focusing on classification and distribution, morphology and anatomy, and description of ecological habits and characteristics. Since the 1980s the studies on tigers were intensively increased and extended to a few fields such as anatomy and histology, biochemistry and physiology, feeding and breeding, ecology, genetics, and diseases, etc.. So far, a total of about 79 papers were published on tigers. The purpose of this paper is to review the tiger research in China.

Classification and distribution

So far, 8 subspecies of tiger were distributed around the world. These subspecies include Bengal tiger (*Panthera tigris tigris*), Siberian tiger (*P. t. altaica*), South-China tiger (*P. t. amoyensis*), Caspian tiger (*P. t. virgata*), Javan tiger (*P. t. sondaica*), Bali tiger (*P. t. balica*), Sumatra tiger (*P. t. sumatrae*), and Indo-Chinese tiger (*P. t. corbetti*). Caspian tiger, Javan tiger, and Bali tiger have been wiped off. The other subspecies are facing hard endangered situation; In China there are four endangered subspecies, they are Siberian tiger, South-China tiger, Bengal tiger and Indo-Chinese tiger.

The Siberian tiger was once distributed in most regions of northern China. However, its distribution is less and limited to the several mountain areas of Heilongjiang Province and eastern forest areas of Jilin Province. During 1988-1991, it was estimated that there were 10-14 Siberian tigers in Heilongjiang Province (Wu 1994). Results of a research team from USA, Russia and China indicated that there were 4-6 Siberian tigers in Jilin Province. At present, the South-China tigers can only be occasionally encountered in the separate mountain areas of Guangdong, Fujian, Jiangxi, and Hunan Provinces and has an extremely small population. From 1990 to 1992, results of the cooperated investigation between the China Ministry of Forestry and the World Wildlife Foundation (WWF) showed that there were about 20-30 tigers in the wild (Yuan *et al.* 1994). The Bengal tigers only lived in southern areas of Yunnan and some parts of southern Tibet. The number of the population was estimated at about 30 (Meng 1995). The Indo-Chinese tigers can be found in southern Yunnan and southwestern Guangxi. According to records of fur trade and field investigation, there were 30-40 tigers in China (Meng 1995).

Morphology and anatomy

A few reports have been published on morphology and anatomy of tigers. Zhang Shuyun and Wang Dongfeng (1993) studied the weight of main organs and length of intestinal tubes, and found that there existed the apparent differences between adults and sub-adults. Jin Longzhu (1987) measured main internal organs. Zhang Guangxiang *et al.* (1991) and other researchers (Chang and Zhang 1986) studied the external shape of wild tigers, measured the skeleton and internal organs, and compared weight and length of the whole parts.

Physiology and biochemistry

Much work has been done on the physiology and

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biochemistry of tigers. Xü Xianzhu *et al.* (1997) measured 19 amino acids in the mixture of livers of 8 Siberian tigers and found that the amount of each amino acid (AA) was higher than that of other animals. The sum of all AA accounted for 65.08% in the extremely dry liver. All AA, which are necessary to animals, existed in the livers of Siberian tigers. Similar study was conducted in the Siberian tiger (Zhao *et al.* 1994) using the same approach. They indicated that amount of all AA was also higher, up to 75.44% of dry spleen and 20.44% of fresh spleen. 19 water-soluble amino acids of proteins were analyzed in the mixture of kidneys of eight Siberian tigers (Liu *et al.* 1994). Results demonstrated that the total amount of amino acids reached as high as 68.34% of the absolute dry weight of kidneys, equivalent to 21.57% of the wet weight of fresh kidneys. Proportions of different amino acids were relatively moderate, including the nine essential amino acids which content and distribution were rather abundant and moderate.

Yang Xuedong *et al.* (1994,1995) and Zhao Guangying *et al.* (1994) analyzed the amount of protein and the water contents of spleen, livers and kidneys of the Siberian tigers. They indicated that content of water was 72.96% in spleen, 68.52%±1.93% in kidneys, and 65.16%±0.55% in livers. The amount of protein accounted for 82.17%±2.14% of the dry weight of spleen, about 22.22% ±1.27% of the wet weight of fresh spleen. In kidneys and livers the content of protein was 69.16%±2.64% and 72.68%±1.11% of the dry weight, equivalent to 21.74%±1.21% and 25.32%±0.46% of the wet weight, respectively. The protein of these organs is much abundant and has higher biological values.

Zhang Li *et al.* (1994) determined the contents of 11 metallic macro and microelements in eight Siberian tigers using Inductance Coupled Plasma Analysis and Emission Spectrum method. Results indicated that the contents of all elements did not have the significant differences between sexes and ages. Jin Xiuyan *et al.* (1994) found that the contents of potassium of blood serum in eight Siberian tigers reached (114.0±34.0) mg/L.

Xü Xianzhu *et al.* (1997) reported the contents of blood serum in eight Siberian tigers, indicating that the content of total protein was (73.6±12.6) mg/L, the albumin content and that of globulin was (46.5±3.3) mg/L, (27.1±13.7) mg/L, respectively. Zhao Guanying *et al.* (1995) analyzed and measured blood components of the Siberian tigers, including diameter of red blood cell, osmotic fragility of red blood cell, neutrophil, oxyphil cell, basophilic cell, lymphocyte, mononuclear cell, and mean erythrocytic hemoglobin concentration, etc.. Zhang Decheng *et al.* (1993) analyzed immune complexes and C_3b receptors on erythrocytes in the Siberian tiger, clouded leopard, and golden cat. Results demonstrated that erythrocytes of these carnivores had not only immune adherence and formed ring compound of immune complexes, but also formed ring compound of C_3b receptors. This suggested that red blood cell of the Siberian tiger had a stronger immune function.

Ecology

Before 1980s the studies on ecology of tigers were only limited to description of ecological habits and characteristics. In recent years, much more attention has been paid on behavioral ecology, including breeding, agonistic and feeding behavior, etc.. Sheng Yongqing (1989) observed feeding behavior of tigers in captivity tigers and he found that tigers preferred a certain kind of food, ate dead animals, and were afraid of living preys in the zoo. He suggested that tigers are losing their ability to capture preys under captive condition. Zhao Yunhua *et al.* (1992) intensively described the breeding behavior of Siberian tigers in the zoo, including oestrus, copulation, and gestation, bearing behavior. Liu Li (1995) described and analyzed agonistic behavior of the Siberian tigers. In this study, she observed this kind of behavior from 5 December in 1993 to 7 January in 1994, and suggested that the shortage of foods was probably responsible for this behavior. Apart from behavioral studies, some studies have been done on the habitats of South-China tigers in southern provinces (Yuan *et al.* 1994). These studies all suggested that the habitats of tigers were deteriorating. And much work was urgently needed for the conservation and management of tiger habitats all over the country.

Disease

It is very difficult to study diseases of tigers in the wild since the tiger is a large and threaten carnivore. So far much work in this field was done under captive condition. Mei Quanlin *et al.* (1992) investigated intestine parasites of 33 Siberian tigers in captivity. Results indicated that toxascais lelonina was a kind of main parasite that led to 63.14% of infection. Wei Wanchun *et al.* (1982) described clinical symptom and pathologists check of Carcinoma of breast in Siberian tigers. Yang Jiguang *et al.* (1983) reported clinical symptom and pathoanatony of aplastic anemia, and indicated that the infection of digestive caused about this disease. Lü Zejian (1981) probed into acute bacterial dysentery of young South-China tigers. He described symptom, check, diagnose, and treatment of this disease. He suggested that infusion and controlling infection were fundamental measures for the treatment of this disease.

Genetics

The chromosomes of tigers were commonly reported in the 1960s in the western countries (Hsu 1965, 1968). However, a little information is available on genetics of tigers in China. Zhang Xiran (1991) firstly reported nuclear type and silver staining of south-China tigers using the culture technique of kidney cell. He also investigated G-banding patterns, C-banding patterns, and Ag-NORs distribution feature of the chromosomes in Siberian and South-China tigers (Zhang *et al.* 1993). Results indicated that these two subspecies not only had same non-banding karyotyes but also G-banding, C-banding, and silver-staining karyotypes were very similar.

Feeding and breeding

As yet, much research work has been done on this aspect. The reports and papers published in this field accounted for about 27.8% of tiger literatures, most focusing on feeding, breeding, and artificial lactation. Most of research work involves feeding and management of tigers in captivity, including selection and taming of studs, design and construction of different kinds of cages, mutual coordination between managers and stuff, etc. With the increase of tiger number in the zoo more and more people come to realize that nutrition is playing an important role in the feeding of tigers.

It was found that female tigers sometimes did not care for the young and eventually abandoned their offspring under captive condition (Zhao *et al.* 1991; Gu and Zhang 1979). Female tigers usually bear from two to five cubs (Ma and Yan 1998). It was suggested that we must care for young cubs artificially. During artificial lactation, it is important to keep warm, supply fine milk and various vitamins, set forth-serious immune system and so on.

As a large endangered carnivore, tiger has a problem with breeding in captivity. Thus, much work of this aspect is needed in order to improve survival of tigers under captive condition. Huang (Huang *et al.* 1988) and Song (Song *et al.* 1981) carried out a test of biparous breeding in one year and increased survival rate. Some researchers discussed the inbreeding of Siberian tigers, and suggested that inbreeding did not at all have a negative effect on offspring (Zhang *et al.* 1991).

Perspectives and challenges of the tiger research in the future

Tigers are declining dramatically in number all over the world. The report by the World Wildlife Foundation (WWW) indicated that the number and area of habitats of tigers have reduced 95% during the past years. Three subspecies (Caspian tiger, Javan tiger and Bali tiger) have died out. As a result conservation of tiger has been given the first priority. The tigers have been put in the first place of 10 most endangered species in the world. In addition international wildlife conservation organization laid down a lot of important international treaties on tigers, and many countries established nature reserves and national parks. Each year lots of monographs, reports, and papers are published on tigers, involving biology, management, conservation and so on.

However, tigers have been on the brink of extinction because of much hunting and deterioration of habitats. Although attention have been paid to some aspects of tiger research, much and systematic work is needed in the future, particularly considering that there is still a large gap on tiger research compared with international research teams in many aspects. Particularly, the tiger research in China is facing some serious problems. Most studies on tigers began too late, and the whole development work of research was low. Little work was done before 1980s although there were 79 papers about tigers published so far.

Fields of tiger research were limited. As yet, most work is mainly focused on feeding, breeding, and biochemistry. However, little was done on ecology, genetics, and management. Moreover, research was narrowed to limited areas in the specific field. For example, in ecological study, research only involved the behavior whereas dynamics of wild populations and other aspects have given little attention.

Tiger studies were short of systematization. For example, in behavioral studies, only a few kinds of behaviors were described, moreover the researchers have paid no attention to the relation with the behavior of captive and wild tigers. In the breeding studies, many researchers observed the whole course of mating, but they did not analyzed how to increase breeding success rate and improve declining condition of gene, etc.

From the above discussion, the following aspects of tiger research should be emphasized and strengthened in the near future.

Breeding research is an important field that is closely related to the increase of tiger number under captive condition. Thus, we must strengthen the study of this aspect. In the past studies only some behaviors of mating were observed and recorded. However, this was apparently insufficient. We believe that the breeding techniques should be improved and reinforced, including sperm vitality, pregnancy diagnose, breeding obstruct, artificial semination, survival rate and so on. The current situation of tiger breeding can only be improved by doing so.

Genetics study is an essential guarantee that increases the diversity of gene and improves genetic status of populations in captivity. Tigers in the zoo have a serious inbreeding and their wild genes have lost more than 20%. In order to improve this situation and keep the genetic diversity of population, we not only emphasize breeding work, but also pay attention to those tigers with higher genetic value and make them breed more offspring. Otherwise we should build gene bank of wild tigers so that we can create more chance for the future study.

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